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Brice, Jr. et al.

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(54) **AUTHENTICATING A PROCESSING SYSTEM ACCESSING A RESOURCE**

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CPC ***G06F 9/5005*** (2013.01); ***G06F 3/0622*** (2013.01); ***G06F 3/0637*** (2013.01); ***G06F 3/0659*** (2013.01); ***G06F 3/0683*** (2013.01); *G06F 9/455* (2013.01); *G06F 9/46* (2013.01)

(58) **Field of Classification Search**
CPC G06F 9/455; G06F 9/52; G06F 9/46
See application file for complete search history.

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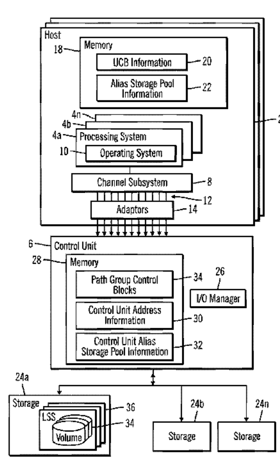
(57) **ABSTRACT**

Provided are a method, system, and article of manufacture for authenticating a processing system accessing a resource. An association of processing system identifiers with resources, including a first and second resources, is maintained. A request from a requesting processing system in a host is received for use of a first resource that provides access to a second resource, wherein the request is generated by processing system software and wherein the request further includes a submitted processing system identifier included in the request by host hardware in the host. A determination is made as to whether the submitted processing system identifier is one of the processing system identifiers associated with the first and second resources. The requesting processing system is provided access to the first resource that the processing system uses to access the second resource.

18 Claims, 4 Drawing Sheets



(51) **Int. Cl.**

G06F 9/50	(2006.01)
G06F 3/06	(2006.01)

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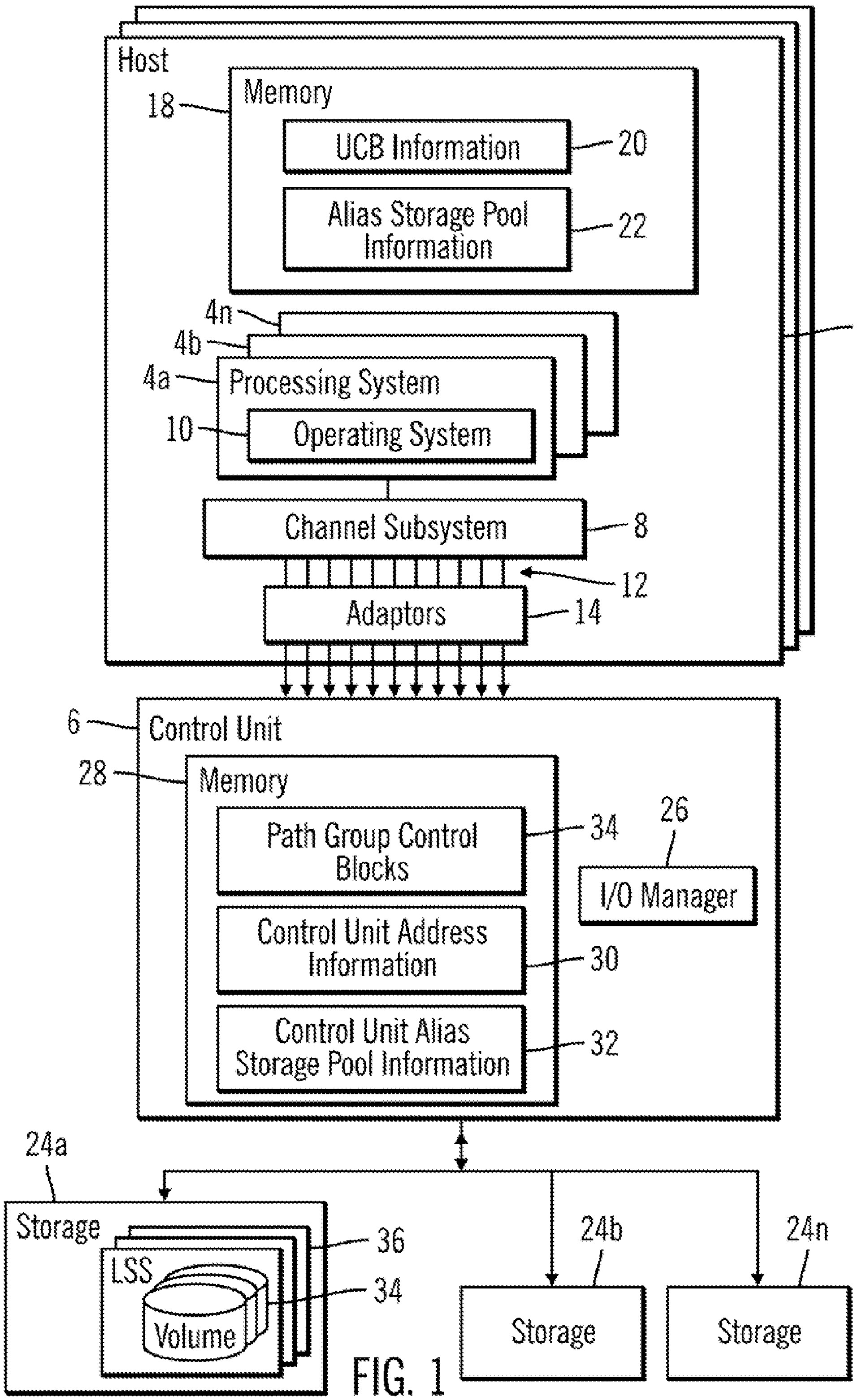

Host
Memory
18
UCB Information
20
Alias Storage Pool Information
22
4n
4b
4a
Processing System
10
Operating System
2
Channel Subsystem
8
12
Adaptors
14
6
Control Unit
28
Memory
Path Group Control Blocks
34
26
I/O Manager
Control Unit Address Information
30
Control Unit Alias Storage Pool Information
32
24a
Storage
36
LSS
34
Volume
24b
24n
Storage
Storage

FIG. 1

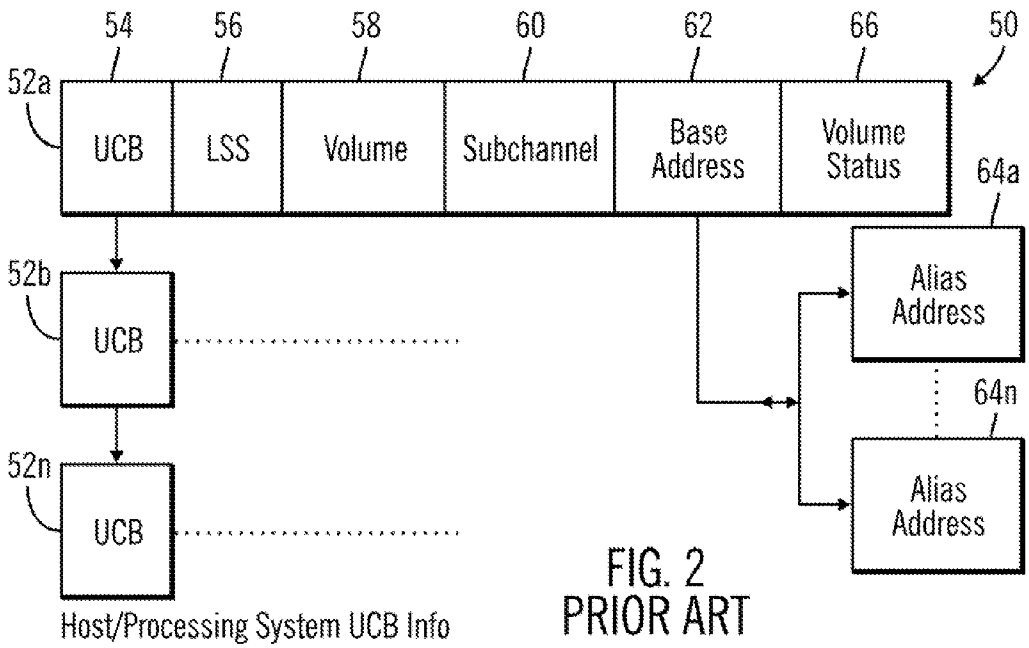


FIG. 2
PRIOR ART

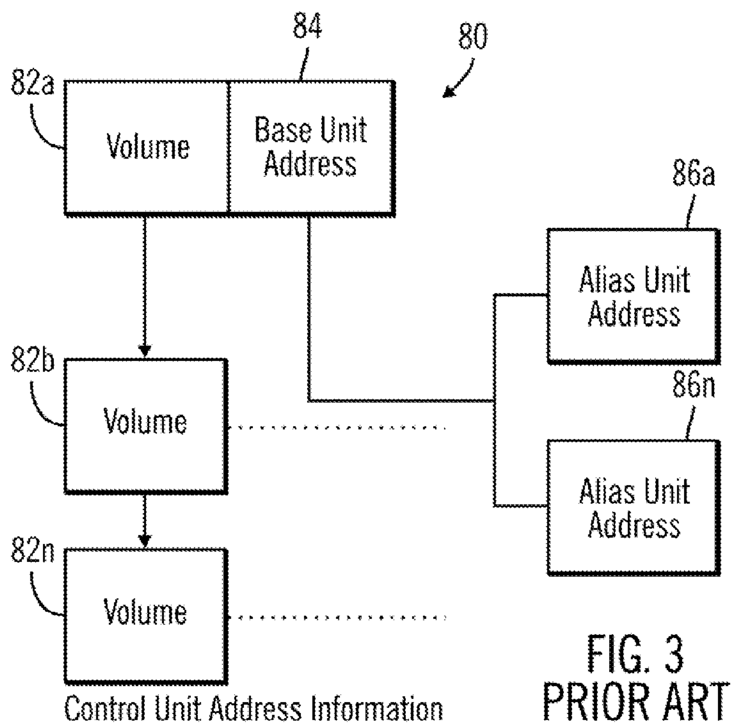


FIG. 3
PRIOR ART

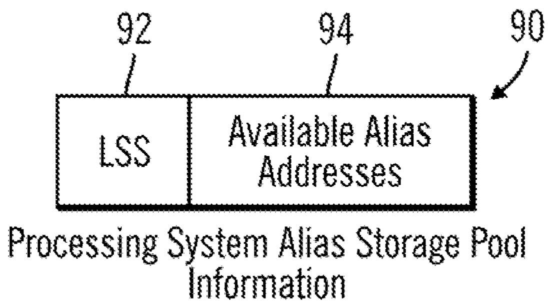


FIG. 4
PRIOR ART

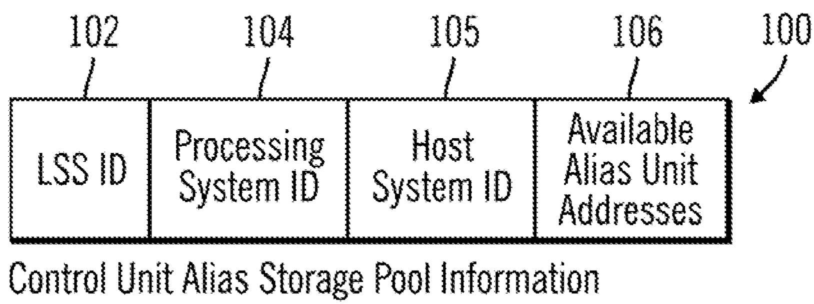


FIG. 5

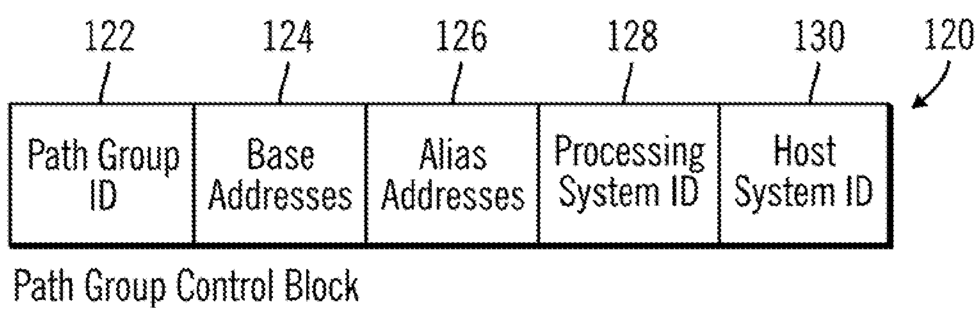
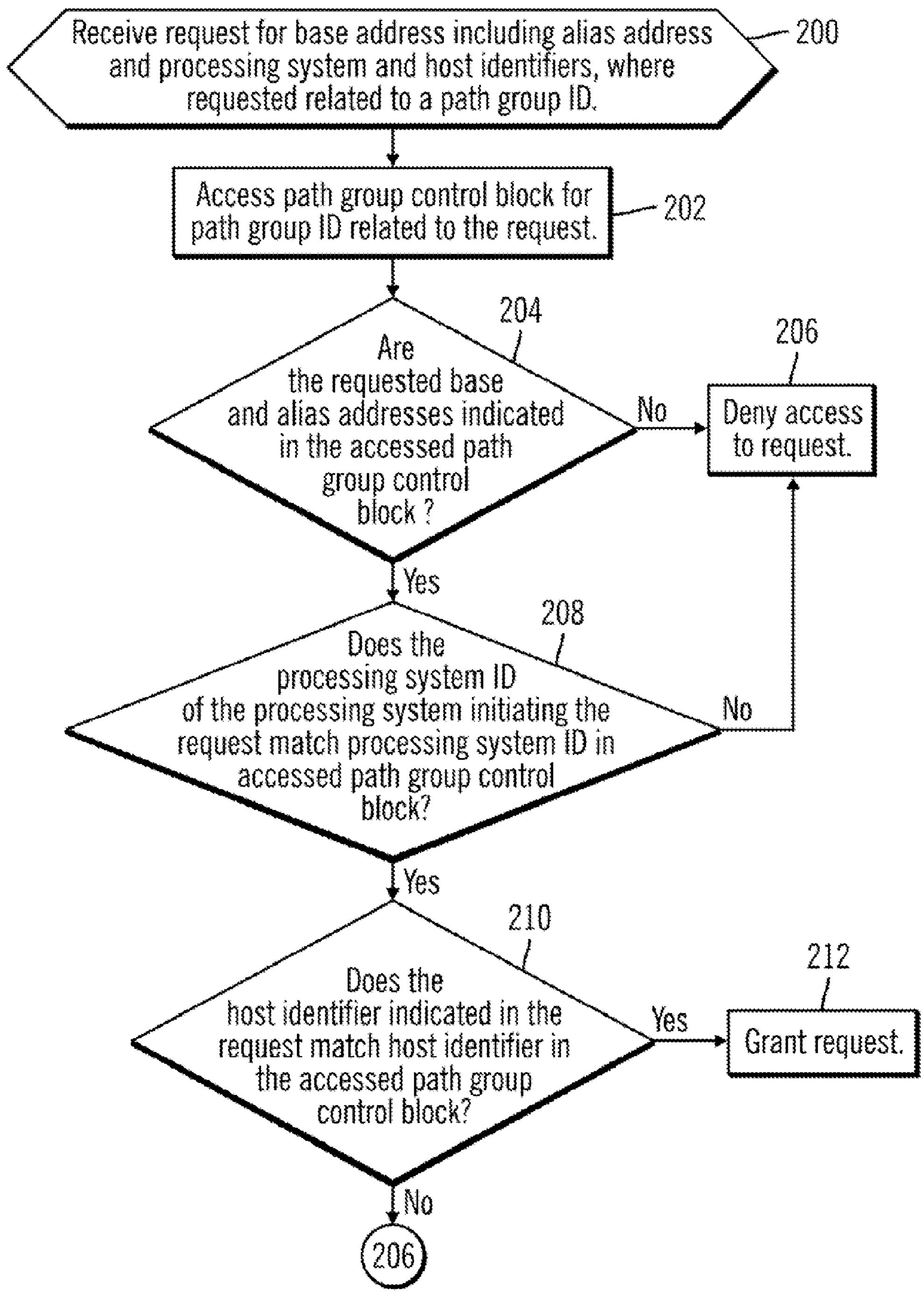


FIG. 6



Receive request for base address including alias address and processing system and host identifiers, where requested related to a path group ID.
200
Access path group control block for path group ID related to the request.
202
Are the requested base and alias addresses indicated in the accessed path group control block ?
204
No
206
Deny access to request.
Yes
Does the processing system ID of the processing system initiating the request match processing system ID in accessed path group control block?
208
No
Yes
Does the host identifier indicated in the request match host identifier in the accessed path group control block?
210
Yes
212
Grant request.
No
206

FIG. 7

AUTHENTICATING A PROCESSING SYSTEM ACCESSING A RESOURCE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 13/460,316, filed Apr. 30, 2012, which is a continuation of U.S. patent application Ser. No. 12/030,147, filed Feb. 12, 2008, which applications are incorporated herein by reference in their entirety.

BACKGROUND

1. Field

The present invention relates to a method, system, and program for authenticating a processing system accessing a resource.

2. Description of the Related Art

In certain computing environments, multiple host systems may communicate with multiple control units (CUs) (also known as storage controllers, storage subsystems, enterprise storage servers, etc.) providing access to storage devices, such as interconnected hard disk drives through one or more logical paths. The interconnected drives may be configured as a Direct Access Storage Device (DASD), Redundant Array of Independent Disks (RAID), Just a Bunch of Disks (JBOD), etc. The control unit may configure one or more logical subsystems (LSSs), where each LSS may be configured to include multiple volumes.

The host system may include a channel subsystem that maintains information to access volumes in an LSS in the control unit. The channel subsystem includes subchannels, which provides state tracking for the execution of the I/O operations for the channel subsystem and provides information on paths connecting the host to a volume in an LSS. The host operating system maintains a unit control block (UCB) providing information on a base unit address assigned to one volume and the subchannel that the channel subsystem uses to access the volume on the base device. The channel subsystem is aware of individual subchannels and the paths they have. In one implementation, the control unit may dynamically assign aliases from a pool of aliases when needed for host I/O operations and when the I/O operation completes, the alias address is returned to the pool for use with a subsequent I/O request. In this way, an alias is assigned for a single I/O request. In a static implementation, the customer may initially assign aliases to bases via external tools to the control unit and the aliases are used for I/O requests directed to the bases to which they are assigned.

Further, the control unit may assign alias addresses to the base addresses for volumes, where the alias addresses are used to allow concurrent I/O requests to be directed to the same volume. The control unit maintains information associating a base volume with the alias addresses assigned to that volume. The host processes the information in the UCB to address an I/O operation to a volume. In particular, the host initiates an I/O operation toward a volume by initiating a channel program which consists of a series of I/O instructions, such as a chain of channel command word (CCW) commands, at the subchannel.

The control unit maintains a different view of the system. The control unit is provided a base unit address for each device (volume) and zero or more alias unit addresses for each base unit address. After assigning a base address to each volume (device), the remaining addresses can be allocated as alias addresses to the base addresses. The control unit uses the unit addresses to physically access the volumes.

An I/O operation or chain of CCW commands can be simultaneously executed toward the same logical volume using the different base and alias unit addresses for the logical volume. In this way, the executed CCW commands are all directed toward the same logical volume using different addresses, wherein each address uses one of multiple channel paths to reach a single logical volume. This allows a single host to concurrently execute multiple I/O operations against a single volume. The number of aliases provided for a base may be set according to the size of the volume and the number of concurrent users. In certain cases, only a few aliases may be needed to accommodate network, e.g., Storage Area Network (SAN), traffic for a particular base address for a volume.

The host first attempts to access a volume (I/O device) through the base UCB for the volume. If the base UCB is unavailable, i.e., concurrently servicing another I/O operation, then the host may use one of the available alias UCBs assigned to that base UCB to concurrently access the volume. The host system then performs the I/O operations through the subchannel associated with the UCB and the channel paths provided for that subchannel.

SUMMARY

Provided are a method, system, and article of manufacture for authenticating a processing system accessing a resource. An association of processing system identifiers with resources, including a first and second resources, is maintained. A request from a requesting processing system in a host is received for use of a first resource that provides access to a second resource, wherein the request is generated by processing system software and wherein the request further includes a submitted processing system identifier included in the request by host hardware in the host. A determination is made as to whether the submitted processing system identifier is one of the processing system identifiers associated with the first and second resources. The requesting processing system is provided access to the first resource that the processing system uses to access the second resource.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an embodiment of a computing environment.

FIGS. **2** and **4** illustrate embodiments of information a host maintains to access volumes known in the prior art.

FIGS. **3** and **5** illustrate embodiments of information a control unit maintains to allow a host to access volumes managed by the control unit. The information of FIG. **3** is known in the prior art.

FIG. **6** illustrates an embodiment of information associated with a path group.

FIG. **7** illustrates an embodiment of operations to process a request to remove an alias address control block from the alias address pool.

DETAILED DESCRIPTION

FIG. **1** illustrates a computing environment in which aspects of the invention are implemented. One or more hosts **2** (only one is shown) include one or more processing systems **4***a*, **4***b* . . . **4***n* that communicate Input/Output (I/O) requests to a control unit **6** through a channel subsystem **8** that provides a plurality of logical paths to the control unit **6**. Each processing system **4***a*, **4***b* . . . **4***n* includes an operating system **10** to manage path related operations. The channel subsystem **8** manages logical paths **12** extending through adaptors **14**. An adaptor provides the physical layer through which logical paths **12** extend to the control unit **6** or multiple control units through a switch (not shown). The operating system **10** may further associate multiple logical paths **12** with a path group, where all the paths in a path group may be used by one processing system **4***a*, **4***b* . . . **4***n* to communicate with the control unit **6**. A path group used by one processing system **4***a*, **4***b* . . . **4***n* may be identified by a path group identifier (PGID). The operating system **10** may issue an I/O command (such as a Set Path Group ID CCW) to each path for the device using a world wide unique identifier (PGID). The control unit **6** creates a path group from the set of paths for a device that have the same PGID identifier.

In one embodiment, the channel subsystem **8** may be implemented as firmware or microcode. The channel subsystem **8** may be implemented in dedicated hardware comprising a separate set of integrated circuit chips.

Each processing system **4***a*, **4***b* . . . **4***n* may comprise a virtual machine, such as a logical partition (LPAR), to which computer resources, such as one or more central processing units (CPU) and memory resources are assigned. Each processing system **4***a*, **4***b* . . . **4***n* may execute their own operating system **10**, device drivers, and may execute channel subsystem **8** code. In further embodiments, each processing system may comprise a logical partition of a processor. In this way, one or more processors in the host **2** may implement multiple logical partitions (LPARs). Multiple processing systems **4***a*, **4***b* . . . **4***n* may share a single logical channel subsystem **16** or different processing systems **4***a*, **4***b* . . . **4***n* may use different logical channel subsystems.

The channel subsystem **8** performs the operations to communicate I/O requests from the processing systems **4***a*, **4***b* . . . **4***n* to the control unit **6**. The operating system **10** uses UCBs and manages I/O requests. The channel subsystem **8** obtains the I/O request from the channel subsystem **8**. A memory **18**, comprised of one or more memory devices, includes information used by the channel subsystem **8** to manage I/O requests. Each processing system **4***a*, **4***b* . . . **4***n* maintains its own UCB and alias storage pool information providing information on the UCB chains for each processing system **4***a*, **4***b* . . . **4***n*. Different processing systems **4***a*, **4***b* . . . **4***n* may have different UCB chains having different alias addresses assigned to the base addresses for a particular processing system.

The host memory **18** further includes alias storage pool information **22** providing information on the assignment of available alias addresses for different logical subsystems (LSS) **36** for the processing systems **4***a*, **4***b* . . . **4***n*, such that different processing systems **4***a*, **4***b* . . . **4***n* may use the same alias address for different base addresses. Further, different processing systems **4***a*, **4***b* . . . **4***n* may use the same alias address to for different base addresses, to assign the aliases in different configurations to the volumes and alias storage pool. In one embodiment, the memory **18** may maintain the UCB information **20** and alias storage pool information **22** for all processing systems **4***a*, **4***b* . . . **4***n* and LSSs **36**, which is shared for all processing system operations at the same time. In a further embodiment, each processing system may maintain in its own memory the UCB information **20** and alias storage pool information **22** for that processing system **4***a*, **4***b* . . . **4***n*.

In one embodiment, there is a separate host memory **18** local to each processing system **4***a*, **4***b* . . . **4***n* operating system image. In one embodiment, the relationship of aliases to bases is maintained in the control unit address information **30** and with the operating system image for each processing system **4***a*, **4***b* . . . **4***n*. There may be an instance of the control unit address information **30** for each processing system **4***a*, **4***b* . . . **4***n* and LSS **36**, where each instance of the control unit alias address information **32** may comprise the information shown in FIG. **5**. In an alternative embodiment, the control unit address information **30** may be maintained local in the operating system image for each processing system **4***a*, **4***b* . . . **4***n* and only persistent in the control unit **6** address information **30** for the duration of the I/O.

The control unit **6** manages requests from the processing systems **4***a*, **4***b* . . . **4***n* to access storage systems **24***a*, **24***b* . . . **24***n*, such as tracks, partitions, logical devices, logical volumes, logical unit numbers (LUNs), logical subsystems (LSS) or other logical or physical units of storage. Storage **24***a* shows a configuration including one or more LSSs **32**, where one or more volumes **34** are configured in each LSS **36**. The volumes may extend across multiple storage devices. The term "device" refers to any physical or logical data storage unit, such as a physical track, LSS, partition, logical volume, volume, etc. The control unit **6** includes an I/O manager program **26** to process I/O requests to the storages **24***a*, **24***b* . . . **24***n* and logical and physical components configured therein, e.g., volumes, LSSs, etc. The control unit **6** has a control unit memory **28**, comprised of one or more memory devices, in which the I/O manager **26** maintains control unit address information **30** having the assignment of base and alias addresses for defined storage units, such as volumes within a logical subsystem (LSS). The memory **28** further includes control unit alias storage pool information **32** having information on the alias addresses available for the processing systems **4***a*, **4***b* . . . **4***n*. The memory **28** also includes path group control blocks (PGCB) **34** providing information on a path group of logical paths used by a processing system **4***a*, **4***b* . . . **4***n*. A PGCB is created by the I/O manager **26** when the processing system **4***a*, **4***b* . . . **4***n* establishes a path group with the control unit **6**, where the established path group comprises logical paths the processing system **4***a*, **4***b* . . . **4***n* uses to communicate with the control unit **6** and submit I/O requests and receive responses to the submitted I/O requests. The processing system **4***a*, **4***b* . . . **4***n* and control unit **6** may select any logical path in the path group established for the processing system **4***a*, **4***b* . . . **4***n* to communicate requests, information and alerts.

The hosts **2** may comprise computational devices known in the art, such as a workstation, mainframe, server, etc. The control unit **6** may comprise a storage subsystem or server, such as an enterprise storage server, storage controller, etc., or other device used to manage I/O requests to attached volumes. The storages **24***a*, **24***b* . . . **24***n* may comprise storage devices known in the art, such as interconnected hard disk drives (e.g., configured as a DASD, RAID, JBOD, virtualized devices, etc.), magnetic tape, electronic memory, flash memory, optical disk, etc. The host **2** may communicate with the control unit **6** over the logical paths **12**, which may extend through a network, such as a Local Area Network (LAN), Storage Area Network (SAN), Wide Area Network (WAN), peer-to-peer network, wireless network, etc. Alternatively, the host **2** may communicate with the storage controller **6** over a bus interface, such as a Peripheral Component Interconnect (PCI) bus or serial interface.

FIG. **2** illustrates host/processing system UCB information **50** known in the prior art having information on the assignment of base and alias addresses to the volumes for one processing system **4***a*, **4***b* . . . **4***n* and LSS **36**. An instance of the information **50** would be maintained for each separate processing system **4***a*, **4***b* . . . **4***n* and LSS **36** pair in the host **2**. The instances of the UCB information **50** comprise the UCB information **20**. The information **50** includes UCB entries **52***a*, **52***b* . . . **52***n* for one processing system **4***a*, **4***b* . . . **4***n*, which includes for each UCB in the chain the following information: a UCB identifier **54** of a UCB providing information to access one volume configured in the storages **24***a*, **24***b* . . . **24**; a logical subsystem (LSS) **56** identifying an LSS **36** in which the volume **34** is configured; a volume **58** in the LSS **36** identified in field **56** for which the information is provided; a subchannel **60** of the channel subsystem **8** comprising a subchannel number, index or pointer providing information on the volume; a base address **62** for the subchannel; and one or more alias addresses **64***a* . . . **64***n* used to additionally address the volume (if any have been assigned); and volume status **66** providing information on the status of the volume. In certain embodiments, alias addresses are only associated with a specific base address **62** when an I/O operation is active for that base (volume). Otherwise the aliases reside in a pool of available aliases not associated with any specific base (volume).

In one embodiment, alias addresses may be initially associated with bases in the storage subsystem (LSS) of the control unit **6**. If the storage subsystem supports the alias address pooling, then the operating system **10** issues a "set subsystem characteristics command" to tell the control unit **6** to operate in a mode where alias addresses are pooled and assigned only when needed. This command causes the alias addresses to no longer be associated with a specific base address **62** for that processing system **4***a*, **4***b* . . . **4***n*. Each operating system in a processing system **4***a*, **4***b* . . . **4***n* can change their alias addressing modes independently. At this point, the alias addresses are available to be assigned to a base address **62** as I/O operations are started, and returned to the pool as operations complete. Likewise, the devices in the LSS can be switched by the customer back to the original mode of operation where aliases are statically assigned to base addresses. In this way, the operating system may transition in and out of the mode where alias addresses are dynamically assigned and used to a mode where they are statically assigned and used.

In the illustrated embodiment of FIG. **2**, the UCB information **50** provides a chain of UCBs **52***a*, **52***b* . . . **52***n* for one processing system **4***a*, **4***b* . . . **4***n* and one LSS **36** configured in the storages **24***a*, **24***b* . . . **24***n*, where each UCB **52***a*, **52***b* . . . **52***n* includes information for one volume. In alternative embodiments, the UCB information **50** may include different information for different storage systems and environments to provide information on base and alias addresses assigned to volumes configured in the storages **24***a*, **24***b* . . . **24***n*. Further, if the system is not implementing channel subsystem technology, then information on the subchannel, such as field **60** may not be included.

FIG. **3** illustrates an embodiment of control unit address information **80** having information known in the prior art on the assignment of base and alias addresses for one processing system **4***a*, **4***b* . . . **4***n* and logical subsystem **32** configured in the storages **24***a*, **24***b* . . . **24***n*. An instance of the information **50** would be maintained for each separate processing system **4***a*, **4***b* . . . **4***n* and each logical subsystem (LSS) that the processing system **4***a*, **4***b* . . . **4***n* may access. The address information **80** includes an entry **82***a* . . . **82***n* for each volume **34** configured in the logical subsystem (LSS) **32** for which the information **80** is maintained. The instances of the control unit address information **80** comprise the control unit address information **30**. Each entry **82***a*, **82***b* . . . **82***n* (FIG. **3**) includes: a volume identifier **84**; the base address **86** assigned to the volume; and zero or more alias addresses **86***a* . . . **86***n* that may be assigned to the base address **84** to additionally use to access the volume. In a dynamic alias assignment environment, the control unit alias storage pool information **100** (FIG. **5**) is maintained for the duration of an I/O request, and after completing the I/O request the alias addresses are returned to an alias storage pool.

FIG. **4** illustrates an embodiment of processing system storage pool information **90** maintained for one processing system **4***a*, **4***b* . . . **4***n* and one logical subsystem (LSS) **32**. The instance of the processing system storage pool information **90** includes, for one processing system **4***a*, **4***b* . . . **4***n*, the logical subsystem (LSS) **92** to which the information applies and the available alias addresses **94** that may be assigned to volumes configured within the LSS **92**. The instances **90** of the processing system storage pool information for each LSS **36** the processing systems **4***a*, **4***b* . . . **4***n* may access comprises the alias storage pool information **22**.

FIG. **5** illustrates an embodiment of control unit alias storage pool information **100** maintained for one logical subsystem (LSS) **32** and one processing system **4***a*, **4***b* . . . **4***n*. The instance of the control unit system storage pool information **100** includes, for one processing system **4***a*, **4***b* . . . **4***n* and logical subsystem **32**, the logical subsystem (LSS) identifier **102**, the processing system ID **104** to which the information applies, the host system ID **105** in which the processing system **104** is included, and the available alias addresses **106** that may be assigned to volumes **34** configured within the LSS **102** for the processing system **104** in the host **105**. The processing system **104** information may comprise a host logical address and may be transmitted with the I/O request. Each processing system **4***a*, **4***b* . . . **4***n* may have a unique host logical address within the host **2**, but may not be unique between hosts **2**. The channel subsystem **8** may provide each processing system **4***a*, **4***b* . . . **4***n* its ID or host logical address. The host system ID **105** may comprise a world wide node name (WWNN) of the host **2**. The host system ID **105** is unique among hosts. A node descriptor identifies the channel or adaptor **14**, where each adaptor **14** provides one path. Each host **2** can have multiple node descriptors, one for each adaptor **14** in the host, and each node descriptor provides a unique identifier for one adaptor **14**, such as a host bus adaptor (HBA). Further, each node descriptor may include the machine serial number of the host **2** in which the adaptor **14** is included. Thus, all node descriptors for adaptors **14** in one host **2** have a common host machine serial number of the host in which they are included, which may comprise the host ID, e.g., the WWNN of the host.

In alternative embodiments, the storage pool information **90** may include different information for different storage systems and environments to provide information on base and alias addresses assigned to volumes configured in the storages **18***a*, **18***b* . . . **18***n*. The control unit alias storage pool information **30** comprises one instance **100** of the processing system storage pool information for each LSS and processing system **4***a*, **4***b* . . . **4***n*.

FIG. **6** illustrates an embodiment of a path group control block **120** including information associated with a path group established for one processing system **4***a*, **4***b* . . . **4***n* comprising logical paths used for communication between the processing system **4**a, **4**b . . . **4**n and control unit **2**. A path group control block **120** includes a path group identifier (PGID) **122** identifying the path group, base addresses **124** of volumes **34** assigned to the path group, alias addresses **126** assigned to the path group that may be used to access the volumes or shared resources identified by the base addresses **124**, a processing system identifier (ID) **128** for the processing system **4**a, **4**b . . . **4**n (such as a node descriptor) for which the path group was established, and a host system identifier **130** of the host system **2** including the processing system **4**a, **4**b . . . **4**n assigned to the path group identified by the PGID **122**. In one embodiment, the processing system ID **128** and host system ID **130** are included by host **2** hardware in commands from a processing system **4**a, **4**b . . . **4**n sent to the control unit **6** to set a path group or submit I/O requests. For instance, the host adaptor **14** ports may send the processing system ID **128** and host system ID **130** to the control unit **6** ports when a logical connection is established. The control unit **6** may then bind the processing system ID **128** and host system ID **130** with the path group identifier **122** in a path group control block **120**. In certain embodiments, only a host **2** with legitimate permission to use a resource, e.g., volume, can establish a path group for the device, so it is the processing system ID **128** and host system ID **130** of a legitimate host that are bound to a path group, identified by a path group ID, for the device, e.g., volume identified by the base address.

In certain embodiments, there may be one base address value present in more than one instance of the path group control block **120**. This situation may occur if two processing systems **4**a and **4**b were each granted permission to access that base address. In such a case, the path group control block **120** containing the processing system ID **128** and the host system ID **130** associated with processing system **4**a would contain the base address in its list of base addresses **124**, and also the separate path group control block **120** containing the processing system ID **128** and the host system ID **130** associated with processing system **4**b would contain the base address in its list of base addresses **124**.

In one embodiment where the processing system **4**a, **4**b . . . **4**n comprises a logical partition, the processing system ID **128** comprises an address of the logical partition assigned by the host **2** architecture, such as the host **2** hardware or firmware to uniquely identify the partition. The host system ID **130** may comprise a world wide name (WWN) identifier of the host **2** that is established in the host **2** hardware or firmware at the time of manufacture. In certain embodiments, software executed by the processing system **4**a, **4**b . . . **4**n, such as the operating system **10**, may not be able to change the processing system ID **128** and host system ID **130**, as this information is configured in host **2** hardware.

FIG. **7** illustrates an embodiment of operations performed by the I/O manager **26** in the control unit **6** to determine whether to execute a processing system **4**a, **4**b . . . **4**n request for a resource, such as a base address, using another resource, such as an alias address. Upon receiving (at block **200**) an I/O request for a base address including an alias address and processing system and host identifiers added by the host **2** hardware, the I/O manager **26** accesses (at block **202**) the path group control block for the path group associated with the request. The processing system **4**a, **4**b . . . **4**n initiating the request may include the path group ID in a chain of commands or at the start of a chain of commands including the I/O request. The I/O manager **26** determines (at block **204**) whether the requested base and alias addresses in the I/O request are indicated in the accessed path group control block **120**. This determination is made to verify that the processing system **2** communicating using a path group ID is authorized to access the alias and base addresses indicated in the I/O request by determining whether the alias and base addresses indicated in the I/O request are associated with the path group ID **122** as indicated in fields **124** and **126** of the path group control block **120** for the path group ID **122**.

If (at block **204**) the requested base and alias addresses are not associated with the path group, e.g., path group ID, on which the request was communicated, then the I/O request is denied (at block **206**), meaning the requesting processing system **4**a, **4**b . . . **4**n is denied access to the requested base address using the provided alias address. If (at block **204**) the requested base and alias addresses are associated with the path group ID, as indicated in the accessed path group control block **120**, then the I/O manager **26** determines (at block **208**) whether the processing system ID of the processing system **4**a, **4**b . . . **4**n initiating the request, which is included in the request by the host **2** hardware, matches the processing system ID **128** indicated in the accessed path group control **120**. Thus, the I/O manager **26** confirms that the processing system **4**a, **4**b . . . **4**n from which the request was initiated, which may be set by host **2** hardware that cannot be modified by processing system **4**a, **4**b . . . **4**n software, such as the operating system **10**, match the processing system ID **28** bound to the path group when the path was established, as indicated in the path group control block **120**.

In one embodiment, the request frame can identify the unique processing system **4**a, **4**b . . . **4**n and host IDs. In one embodiment, the host system ID may not be transmitted in the request frame from the host **2** to the control unit **6**. Instead, the control unit **6** may maintain an association of source IDs and host IDs, and the request frame may have the source ID. In such case, the control unit **6** can determine the host ID associated with the source ID in the request frame, where the request frame may include the processing system ID and the source ID, but not the host ID.

If (at block **208**) the processing system ID provided in the I/O request does not match the processing system ID **128** bound to the path group on which the request is provided, then the I/O manager **26** denies (at block **206**) access to the resource identified by the requested base address. If (at block **208**) the processing ID included in the I/O request matches the processing system ID **128** bound to the path group, as indicated in the path group control block **120**, then the I/O manager **26** determines (at block **210**) whether the host identifier indicated in the request, which is included in the request by host **2** hardware, matches the host ID **130** indicated in the accessed path group control block **120**. If (at block **210**) the host ID in the request matches the host ID **130** bound to the path group, then the request to the resource, e.g., volume, having the base address is granted (at block **212**) using the alias address provided in the request. Otherwise, if the host IDs do not match, then control ends with the I/O manager **26** denying access (at block **206**) to the requested resource identified by the base address.

In an alternative embodiment, if the processing ID included in the I/O request does match the ID **120** bound to the path group, as indicated by the path group control block **120**, then access to the requested base address may be provided through the alias address without performing the additional verifications operations at blocks **210** and **214**.

In the described embodiment of FIG. **7**, the request included an alias address that may be used to access a resource, such as a volume, identified by a base resource indicated in the request. In alternative embodiments, the request may be directed to a computational resource other than a volume identified by a base and alias addresses, such as another storage device component or other type of device.

In a further alternative embodiment, the I/O request includes a request for a first resource that provides access to a second resource, where the request is generated by processing system **4**a, **4**b . . . **4**n, as the operating system **10**, and the request further includes a submitted processing system identifier included in the request by processing system hardware. In such case, the I/O manager **26** determines whether the submitted processing system identifier matches the processing system identifier associated with the first and second resources. In certain embodiments, the first and second resources and processing system identifier may be associated with a path group including a logical path the processing system uses to communicate the I/O request.

The I/O manager **26** may use the path group ID associated with the I/O request to locate the path group control block **120** providing information on associated base and alias addresses, and processing system and host IDs needed to verify the identity of the processing system communicating the I/O request. In one embodiment, to lookup the path group control block **120** for a path group ID associated with the I/O request, the I/O manager **26** may use a hash function of the path group ID to generate an index to an entry in the path group control blocks **34** data structure for the relevant path group ID. In an alternative embodiment, the I/O manager **26** may provide the processing system **4**a, **4**b . . . **4**n a token when the path between the processing system **4**a, **4**b . . . **4**n and path is established, also resulting in the creation of the path group control block **120** for the path. The token may comprise an index to the path group control block **12** for the path in the path group control blocks data structure **34**. The processing system **4**a, **4**b . . . **4**n may then present this token with an I/O request that the I/O manager **26** would then use to locate the corresponding path group control block **120** of the path group on which the request is communicated.

Described embodiments provide techniques to verify the identify of a processing system submitting an I/O request for a first resource to access a second resource, or a request for a volume at an alias address to access the volume identified by a base address. Described embodiments utilize identifiers provide by host hardware to verify the identity of the processing system initiating the request, where the identifiers provided in the request cannot be modified by the processing system software. Using hardware supplied identifiers to verify a processing system helps prevent a processing system from spoofing or presenting identification information of an authorized processing system to gain unauthorized access to the resource.

ADDITIONAL EMBODIMENT DETAILS

The described operations may be implemented as a method, apparatus or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof. The described operations may be implemented as code maintained in a "computer readable medium", where a processor may read and execute the code from the computer readable medium. A computer readable medium may comprise media such as magnetic storage medium (e.g., hard disk drives, floppy disks, tape, etc.), optical storage (CD-ROMs, DVDs, optical disks, etc.), volatile and non-volatile memory devices (e.g., EEPROMs, ROMs, PROMs, RAMs, DRAMs, SRAMs, Flash Memory, firmware, programmable logic, etc.), etc. The code implementing the described operations may further be implemented in hardware logic implemented in a hardware device (e.g., an integrated circuit chip, Programmable Gate Array (PGA), Application Specific Integrated Circuit (ASIC), etc.). Still further, the article of manufacture implementing the code may comprise a receiver or transmitter device or other physical carrier capable of processing or implementing the code as "transmission signals", where transmission signals may propagate through space or through a transmission media, such as an optical fiber, copper wire, etc. The transmission signals in which the code or logic is encoded may further comprise a wireless signal, satellite transmission, radio waves, infrared signals, Bluetooth, etc. The transmission signals in which the code or logic is encoded is capable of being transmitted by a transmitting station and received by a receiving station, where the code or logic encoded in the transmission signal may be decoded and stored in hardware or a computer readable medium at the receiving and transmitting stations or devices. Of course, those skilled in the art will recognize that many modifications may be made to this configuration without departing from the scope of the present invention, and that the article of manufacture may comprise suitable information bearing medium known in the art. The described embodiments discuss information performed by a host operating system to remove an alias address from a pool. In additional embodiments, the operations may be performed by the control unit to manage an alias address pool for a host or host processing system.

In the described embodiments, the host included a channel subsystem to communicate with a control unit. In alternative embodiments, the host and control unit may utilize any suitable client-server architecture and protocols known in the art to communicate and maintain information on base and alias addresses that may be assigned to a volume.

The terms "an embodiment", "embodiment", "embodiments", "the embodiment", "the embodiments", "one or more embodiments", "some embodiments", and "one embodiment" mean "one or more (but not all) embodiments of the present invention(s)" unless expressly specified otherwise.

The terms "including", "comprising", "having" and variations thereof mean "including but not limited to", unless expressly specified otherwise.

The enumerated listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise.

The terms "a", "an" and "the" mean "one or more", unless expressly specified otherwise.

Devices that are in communication with each other need not be in continuous communication with each other, unless expressly specified otherwise. In addition, devices that are in communication with each other may communicate directly or indirectly through one or more intermediaries.

A description of an embodiment with several components in communication with each other does not imply that all such components are required. On the contrary a variety of optional components are described to illustrate the wide variety of possible embodiments.

Further, although process steps, method steps, algorithms or the like may be described in a sequential order, such processes, methods and algorithms may be configured to work in alternate orders. In other words, any sequence or order of steps that may be described does not necessarily indicate a requirement that the steps be performed in that order. The steps of processes described herein may be performed in any order practical. Further, some steps may be performed simultaneously.

When a single device or article is described herein, it will be readily apparent that more than one device/article (whether or not they cooperate) may be used in place of a single device/article. Similarly, where more than one device or article is described herein (whether or not they cooperate), it will be readily apparent that a single device/article may be used in place of the more than one device or article or a different number of devices/articles may be used instead of the shown number of devices or programs. The functionality and/or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality/features. Thus, other embodiments need not include the device itself.

Further, when a reference letter, such as “a”, “b”, or “n” is used to denote a certain number of items, the reference “a”, “b” or “n” used with different elements may indicate the same or different number of such elements.

FIGS. **2**, **3**, **4**, **5**, and **6** show information maintained in a certain format. In alternative embodiments, the information shown in these figures may be maintained in alternative data structures and formats, and in different combinations.

The illustrated operations of FIG. **7** shows certain events occurring in a certain order. In alternative embodiments, certain operations may be performed in a different order, modified or removed. Moreover, steps may be added to the above described logic and still conform to the described embodiments. Further, operations described herein may occur sequentially or certain operations may be processed in parallel. Yet further, operations may be performed by a single processing unit or by distributed processing units.

The foregoing description of various embodiments has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the embodiments to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto. The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended.

What is claimed is:

1. A method, comprising:

maintaining an association of processing system identifiers with resources, including a first and second resources;

receiving a request from a requesting processing system in a host for use of the first resource that provides access to the second resource, and wherein the request includes a submitted processing system identifier, wherein the request is generated by processing system software in the host and wherein a host identifier is included in the received request by host hardware in the host;

determining whether the submitted processing system identifier is associated with the first and second resources; and

providing the requesting processing system access to the first resource that the processing system uses to access the second resource in response to determining that the submitted processing system identifier is associated with the first and second resources, wherein the first resource provides the host identified by the host identifier access to the second resource or an element identified by the second resource.

2. The method of claim **1**, wherein the second resource comprises a base address of a volume, wherein the first resource comprises an alias address to use to access the base address.

3. A method, comprising:

maintaining an association of processing system identifiers with base and alias addresses;

receiving a request from a requesting processing system in a host for use of the alias address that provides access to the base address, wherein the request includes a submitted processing system identifier, and wherein the request is associated with a path group identifier identifying a path group, wherein base and alias addresses are associated with a path group identifier;

determining whether the path group identifier associated with the request is associated with the base and alias addresses in the request;

determining whether the submitted processing system identifier is associated with the path group identifier in response to determining that the path group identifier associated with the request is associated with the base and alias addresses in the request; and

providing the requesting processing system access to the alias address that the processing system uses to access the base address in response to determining that the submitted processing system identifier is associated with the path group identifier associated with the base and alias address in the request.

4. The method of claim **3**, further comprising:

determining whether the host identifier indicated in the request is associated with the path group identifier associated with the request in response to determining that the submitted processing system identifier is associated with the path group identifier, wherein the request to use the alias address to access the base address indicated in the request is granted in response to determining that the host identifier of the host is associated with the path group identifier associated with the request.

5. A system in communication with processing systems in a host, wherein each processing system includes processing system software, comprising:

a computer readable storage medium including an association of processing system identifiers with resources, including a first and second resources;

an Input/Output (“I/O”) manager to perform operations, the operations comprising:

maintaining an association of processing system identifiers with resources, including a first and second resources;

receiving a request from a requesting processing system in a host for use of the first resource that provides access to the second resource, and wherein the request includes a submitted processing system identifier, wherein the request is generated by processing system software in the host and wherein a host identifier is included in the received request by host hardware in the host;

determining whether the submitted processing system identifier is one of the processing system identifiers associated with the first and second resources; and

providing the requesting processing system access to the first resource that the processing system uses to access the second resource in response to determining that the submitted processing system identifier is associated with the first and second resources, wherein the first resource provides the host identified by the host identifier access to the second resource or an element identified by the second resource.

6. The system of claim **5**, wherein the second resource comprises a base address of a volume, wherein the first resource comprises an alias address to use to access the base address.

7. A system in communication with processing systems in a host, wherein each processing system includes processing system software, comprising:

a computer readable storage medium including an association of processing system identifiers with resources, including a first and second resources;

an Input/Output ("I/O") manager to perform operations, the operations comprising:

maintaining an association of processing system identifiers with base and alias addresses;

receiving a request from a requesting processing system in a host for use of the alias address that provides access to the base address, wherein the request includes a submitted processing system identifier, and wherein the request is associated with a path group identifier identifying a path group, wherein base and alias addresses are associated with a path group identifier;

determining whether the path group identifier associated with the request is associated with the base and alias addresses in the request;

determining whether the submitted processing system identifier is associated with the path group identifier in response to determining that the path group identifier associated with the request is associated with the base and alias addresses in the request; and

providing the requesting processing system access to the alias address that the processing system uses to access the base address in response to determining that the submitted processing system identifier is associated with the path group identifier associated with the base and alias address in the request.

8. The system of claim **6**, wherein the operations further comprise:

determining whether the host identifier indicated in the request is associated with the path group identifier associated with the request in response to determining that the submitted processing system identifier is associated with the path group identifier, wherein the request to use the alias address to access the base address indicated in the request is granted in response to determining that the host identifier of the host is associated with the path group identifier associated with the request.

9. An article of manufacture comprising a non-transitory computer readable storage medium implementing an Input/Output (I/O) manager in communication with processing systems in a host, wherein each processing system includes processing system software, wherein the I/O manager is executed to cause operations, the operations comprising:

maintaining an association of processing system identifiers with resources, including a first and second resources;

receiving a request from a requesting processing system in a host for use of the first resource that provides access to the second resource, and wherein the request includes a submitted processing system identifier, wherein the request is generated by processing system software in the host and wherein a host identifier is included in the received request by host hardware in the host;

determining whether the submitted processing system identifier is one of the processing system identifiers associated with the first and second resources; and

providing the requesting processing system access to the first resource that the processing system uses to access the second resource in response to determining that the submitted processing system identifier is associated with the first and second resources, wherein the first resource provides the host identified by the host identifier access to the second resource or an element identified by the second resource.

10. The article of manufacture of claim **9**, wherein the second resource comprises a base address of a volume, wherein the first resource comprises an alias address to use to access the base address.

11. An article of manufacture comprising a non-transitory computer readable storage medium implementing an Input/Output (I/O) manager in communication with processing systems in a host, wherein each processing system includes processing system software, wherein the I/O manager is executed to cause operations, the operations comprising:

maintaining an association of processing system identifiers with base and alias addresses;

receiving a request from a requesting processing system in a host for use of the alias address that provides access to the base address, wherein the request includes a submitted processing system identifier, wherein the request is associated with a path group identifier identifying a path group, wherein base and alias addresses are associated with a path group identifier;

determining whether the path group identifier associated with the request is associated with the base and alias addresses in the request;

determining whether the submitted processing system identifier is associated with the path group identifier in response to determining that the path group identifier associated with the request is associated with the base and alias addresses in the request; and

providing the requesting processing system access to the alias address that the processing system uses to access the base address in response to determining that the submitted processing system identifier is associated with the path group identifier associated with the base and alias address in the request.

12. The article of manufacture of claim **11**, wherein the operations further comprise:

determining whether the host identifier indicated in the request is associated with the path group identifier associated with the request in response to determining that the submitted processing system identifier is associated with the path group identifier, wherein the request to use the alias address to access the base address indicated in the request is granted in response to determining that the host identifier of the host is associated with the path group identifier associated with the request.

13. The method of claim **3**, wherein the determining whether the path group identifier associated with the request is associated with the base and alias addresses in the request comprises determining whether a path group control block identified by the path group identifier in the request indicates the base and alias addresses in the request, and wherein the determining whether the submitted processing system identifier is associated with the path group identifier comprises determining whether path group control block indicates the submitted processing system identifier.

14. The method of claim **4**, wherein the determining whether the host identifier indicated in the request is associated with the path group identifier associated with the request comprises determining whether a path group control block identified by the path group identifier indicated in the request indicates the host identifier indicated in the request match.

15. The system of claim **7**, wherein the determining whether the path group identifier associated with the request is associated with the base and alias addresses in the request comprises determining whether a path group control block identified by the path group identifier in the request indicates the base and alias addresses in the request, and wherein the determining whether the submitted processing system identifier is associated with the path group identifier comprises determining whether path group control block indicates the submitted processing system identifier.

16. The system of claim **8**, wherein the determining whether the host identifier indicated in the request is associated with the path group identifier associated with the request comprises determining whether a path group control block identified by the path group identifier indicated in the request indicates the host identifier indicated in the request match.

17. The article of manufacture of claim **11**, wherein the determining whether the path group identifier associated with the request is associated with the base and alias addresses in the request comprises determining whether a path group control block identified by the path group identifier in the request indicates the base and alias addresses in the request, and wherein the determining whether the submitted processing system identifier is associated with the path group identifier comprises determining whether path group control block indicates the submitted processing system identifier.

18. The article of manufacture of claim **12**, wherein the determining whether the host identifier indicated in the request is associated with the path group identifier associated with the request comprises determining whether a path group control block identified by the path group identifier indicated in the request indicates the host identifier indicated in the request match.

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